me more probable that this was a case in which kidneys injured by scarlet fever were put into active inflammation by their efforts to eliminate the mercury administered for the treatment of the syphilitic infection than that it was one of syphilitic nephritis as claimed by the authors.

Cornil[19] reports the case of a hatmaker, who had been under the toxic influence of mercurial vapor for seven years. He died soon after he was admitted to the hospital suffering from clonic convulsions. He had neither alcoholism nor syphilis. At the autopsy a fatty degeneration of nearly all the striped muscles of the body was found. Mercury was found in the brain. The liver and the kidneys showed a fatty degeneration analogous to that observed in intoxication.

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# THE CARDIOSPLANCHNIC PHENOMENON.

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To my knowledge this is a heretofore undescribed phenomenon as far as its clinical manifestations are concerned. The facts, however, up to the point of its clinical identification, have been fully established by the physiological investigations of others. These facts are correlated to intra-abdominal tension and the effects of such tension on the circulation. It may be apposite before describing the phenomenon in question to succinctly review a few essential points on the subject of intra-abdominal tension. In the norm the latter is greater than the atmospheric pressure, and its positive pressure is exerted on the viscera, which in turn press on the abdominal parietes, causing them to bulge. Should a reverse condition of things prevail, the abdominal walls would become retracted. Positive intra-abdominal pressure is subject to two chief conditions, viz., atmospheric pressure upon the yielding abdominal walls and the contraction of the abdominal muscles. Therefore, intra-abdominal pressure is most pronounced in individuals with well-developed musculature and least evident in multiparous women with flaccid abdominal walls. Clinicians recognize the secondary effects of low intra-abdominal tension in conducing to splanchnoptosis, for with relaxation of the abdominal walls the support to the underlying tissues becomes defective and ptosis of the viscera is the likely result. The effects of reduced intra-abdominal tension on the circulation has received but scant consideration from clinicians—a most lamentable fact, considering the gravity of the issues involved.

Hall and Barnard[1] have contributed exhaustively to this important subject which has been practically elaborated in the excellent work of Campbell.[2] They have demonstrated that there is a tendency of the blood to accumulate in the splanchnic area, with consequent syncope. Like the generality of veins, the great splanchnic veins are very susceptible to pressure, and the amount of blood within them is greatly influenced by pressure on the abdominal walls. Mere pressure of the latter suffices to squeeze out of them a large quantity of blood. Thus, gravity, posture, the accoutrements of dress and other facts greatly influence the amount of blood contained in the splanchnic area. More blood accumulates in the splanchnic veins in the erect than in the recumbent posture, and it is not an uncommon observation for syncope to occur in bedridden patients who are suddenly constrained to leave the bed. The removal of stays in women often induces a feeling of faintness, and the same symptoms may occur when a large quantity of ascitic fluid is removed and in susceptible individuals when the bladder is emptied or feces discharged. There are some subjects who experience a sensation of faintness even in health when much pressure is brought to bear by the abdominal muscles in the evacuation of the bowels, and it is not an uncommon observation to note, when the patient is very ill, that the administration of a purgative may be followed by symptoms of collapse. In all these instances there is a determination of blood to the splanchnic area with consequent brain anæmia. The sensation of faintness or syncope is much accentuated when the abdominal walls are flaccid. Three factors enter into consideration in the mechanism of blood supply to the splanchnic vessels, viz.:

(1) contraction of the abdominal muscles, (2) respiration, and (3) the regulating vasomotor action of the splanchnic vessels. The first factor is an important one, the transversales maintaining the anterior and posterior abdominal walls in fairly close contact, preventing in the erect posture the gravitation of blood to the splanchnic area. The second factor concerns the diaphragmatic descent and pulmonary suction. Each time the diaphragm descends the intra-abdominal vessels are compressed, and the action thus exerted is less evident in the firm arteries than in the flaccid veins, the blood being squeezed from the latter into the right heart. De Jager[3] has shown that even strong pressure upon the abdomen has little or no effect on the arteries, but serves to express a large amount of blood from the splanchnic veins. Hill has also shown that in consequence of some failure in certain compensatory mechanisms the blood gravitates into the splanchnic veins from the right heart, and that abdominal compression will send the blood back from the veins to the right heart, thus re-establishing the circulation. Such compression not only augments the input into the right heart, but likewise increases, according to some observers, the systemic arterial pressure by increasing the peripheral resistance in the splanchnic area. Pulmonary suction refers to the large quantity of blood drawn into the lungs with each inspiration, and this physiological process has not been inaptly compared to a species of dry cupping. Chapman[4] avers "that if at the termination of expiration the quantity of blood in the lungs is from $\frac{1}{15}$ to $\frac{1}{18}$ of the total quantity of blood in the body, at the termination of inspiration it will be from $\frac{1}{12}$ to $\frac{1}{13}$." The pulmonary vessels expand with each inspiration and contract during expiration, the results being an increased flow of blood from the right heart and the lungs; the dilated vessels, as Campbell[5] puts it, "actually suck the blood out of the right heart." The final factor, the splanchnic vasomotor mechanism, in preventing the gravitation of blood into the splanchnic veins, is an important one. Hill and Barnard[6] have demonstrated that the splanchnic vasomotor mechanism suffices to combat this contingency, but when this mechanism is inhibited, as occurs when the splanchnic nerves are cut, a second mechanism is brought into prominence, viz., expiratory compressions of the abdomen occurring simultaneously with inspiratory thoracic suctions, the former squeezing and the latter sucking the blood out of the splanchnic pool. The latter mechanism compensates ineffectually in carrying on the circulation, and is referred to by Campbell[7] as the "respiratory mechanism." That the latter is not as efficient as the vasomotor mechanism is evidenced by the fact that the effects of gravity may be entirely compensated after the injection of curare, which paralyzes the muscles. Both mechanisms may be inhibited by division of the spinal cord at the first dorsal vertebra, and if the animal operated on be held with

the head up all the blood accumulates in the splanchnic veins and the empty heart ceases to beat; if, however, the abdomen of the animal is compressed, the blood is expressed into the heart and the circulation is restored. With the foregoing facts at our command, we will be able to appreciate what I have called the cardiosplanchnic phenomenon. If the lower sternal region—*i. e.*, the sternum contiguous to the heart—is first percussed in the standing and then again in the recumbent posture, one may appreciate a decided alteration in the percussion tone; in the former attitude it is resonant or even hyperresonant, in the latter it is dull or flat. This is the cardiosplanchnic phenomenon. It may be elicited, but less effectively, when the patient is in bed and sits up. Vigorous compression of the abdomen will exaggerate the phenomenon in all instances. Not infrequently the relative cardiac dulness will extend beyond the right border of the sternum. In no instance was this percussional phenomenon absent, although hundreds of individuals were examined. In a few instances the phenomenon was only feebly expressed by mere attitudinal changes, yet reinforcement by abdominal compression made its elicitation easy. A few forced inspirations at once dispelled the phenomenon, and it could likewise be made to disappear by the application of a vacuum cup to the abdomen. If the liver and spleen are percussed, first in the erect and then in the recumbent posture, a decided variation in regional percussion is obtained. In the former attitude the area of dulness is increased; in the latter it is diminished, and the splenic area of normal dulness may completely disappear. Abdominal compression exaggerates the results just as it does in increasing the sternal dulness. These conditions are superadded to the cardiosplanchnic phenomenon. Primarily it is necessary to adjust the discrepancy of my observations with those already accepted, and then to analyze the manifestations which give genesis to the phenomenon. Theoretically, one could assume at the outset that the situs of the heart more nearly approaches the anterior chest wall in the erect than in the recumbent posture, and, indeed, it is not only assumed but accepted by clinicians, that in the latter posture the heart falls away from the thoracic wall. Kingscote[8] perpetuates a similar error by assuming that the predominance of asthmatic seizures at night was caused by the posture of recumbency, the dilated heart in this position causing it to impinge on the vagi. I have shown elsewhere[9] the fallacy of this contention. With the aid of the Roentgen rays the triangular spaces in front and behind the heart are clearly defined in forced inspiration, and the rays give undeniable demonstration that change of posture only slightly modifies, if at all, the spaces in question; in fact, it may be observed that in not a few instances the anterior triangle is diminished and the posterior triangle is increased in recumbency. The foregoing facts contravene the contention that posture influences the relation of the heart to the chest wall. Again, percussional results are often influenced by the prejudiced preconceived ideas of the clinician. The skilled clinicist in his interpretation of percussional phenomena is guided not so much by the ear as by the *tactus eruditus;* thus, palpatory percussion will often yield results which would wholly escape the observer who is influenced only by what he hears and not by what he feels. In the elicitation of the cardiosplanchnic phenomenon, palpatory percussion must be our chief mentor. Others may contend that my lung reflexes (that of contraction and dilatation) and heart reflex may account for the phenomenon in question, but these reflexes have been assiduously eliminated and play no rôle in the cardiosplanchnic phenomenon. It is true that in recumbency the splenic and hepatic areas of dulness become diminished; this is in accordance with the well-known fact that postural changes influence the position of the lung borders, the so-called passive mobility of the lung borders. In recumbency the lower lung border descends about one-half inch lower than in the erect posture. The decrease in hepatic and splenic dulness as associated signs of the cardiosplanchnic phenomenon takes into consideration only the deep or relative hepatic dulness, together with the additional fact that the areas under consideration are diminished to an extent not to be accounted for by mere passive mobility of the lung borders. The cardiosplanchnic phenomenon permits of simple explanation. In the erect posture the blood leaves the right heart, which topographically is beneath the lower sternum, and tends to accumulate in the splanchnic area, whereas recumbency opposes this influence of gravity. Abdominal compression, which in some instances must be vigorous, assists still further in expressing the blood from the splanchnic veins and sending it back to the heart. The same factors prevail with relation to the liver and the spleen, the quantity of blood in the latter viscera being in direct proportion to the amount of blood contained in the splanchnic veins, and in inverse proportion to the amount of blood contained in the heart. Forced inspirations hasten the output of blood from the heart, hence the almost immediate evanescence of the cardiosplanchnic phenomenon after vigorous breathing. To those who seek the elicitation of the phenomenon care must be bestowed on the fact to counsel the subject to conduct superficial breathing, but not to suspend it, for otherwise this manœuvre alone will cause the blood to accumulate in the right heart. Exhaustion of air by means of a vacuum cup to the abdomen will decrease intra-abdominal tension and increase in consequence the quantity of blood in the splanchnic veins. After the latter manœuvre, the right heart chambers will become depleted. I have endeavored by means of the Roentgen rays to determine whether any of the manœuvres already suggested for provoking the cardiosplanchnic phenomenon in any way influence the cardiac diameters, and my investigations show that they do not. If the latter observation is correct, how then are we able to account for the increased dulness of the lower sternum, the necessary concomitant of the cardiosplanchnic phenomenon. The sternum contiguous to the right cardiac ventricle in the norm yields percussional resonance which is caused in the main by the transmission of the percussion blow to the neighboring lung tissue. A percussion blow is propagated from one and one-half to two and one-half inches on the surface, and to a depth of about two and one-half inches. It is evident, then, that in the normal subject the dulness of the right ventricle is not sufficiently pronounced to dampen the sound obtained from the vibration of air within the lung alveoli. It is, however, possible to conceive that if the right ventricle were sufficiently filled or even overfilled with blood—and this is capable of fulfilment without any increase in the dimensions of the cardiac chambers—the normal resonant sound of the lower sternal region would become dull or even flat. Our final endeavor is to show the value of the phenomenon in diagnosis and treatment. In estimating the size of the liver or spleen by percussion we are constrained to regard three factors, viz., position of the patient, the amount of blood in the right heart, and the vigor of respiration. The liver size is normally dependent, in part on the amount of blood which it contains, and this has been estimated by Foster[10] to be equivalent to one-quarter the amount of blood contained in the body. The skilled diagnostician will not find it a difficult task to demonstrate reduction in hepatic and splenic dulness after repeated forced inspirations. Such reduction cannot wholly be accounted for by the opening up of atelectatic lung areas, for in the case of the liver my investigations only refer to the deep or relative hepatic dulness. Supposing the object of our examination is an enlarged liver or spleen, and that we desire to know how much of the enlargement is due to hyperæmia and how much to tissue hyperplasia? Percussion in different attitudes, repeated inspirations, and abdominal compression, if necessary, will solve this question. If a crucial test is to be applied, all that is necessary is to apply a vacuum cup to the abdomen, and then, in accordance with the facts already established, the liver and spleen would still further show augmentation in size by percussion. Of course, each observer must estimate for himself to what degree the normal liver or spleen will enlarge under such conditions.* Supposing a patient complains of sternal pressure, which, if dependent on a dilated heart, would disappear on application of a vacuum cup to the abdomen, the blood would be expressed from the heart to the abdomen and the sensation of pressure would disappear at once. Let us further assume that we are confronted with an abdominal neoplasm and the question arises, are we dealing with a growth connected with the liver or spleen, the application of the vacuum cup may solve the problem, for the latter viscera would show augmentation in size and conversely they would show diminished size were the abdomen compressed. The elicitation of the cardiosplanchnic phenomenon would prove valuable in the differential diagnosis of a dilated heart from a pericardial exudate; in the latter affection it would not be elicited. Idiopathic syncope and vertigo and the vertiginous attacks of Glénard's disease may be attributed to a defective splanchnic vasomotor mechanism. Now, in the average normal subject the cardiosplanchnic phenomenon is fairly evident, but in the conditions just cited it would be exaggerated. In other words, the more perfect the mechanism, the less pronounced the phenomenon. A large number of respiratory affections owe their dyspnœa to an overtaxed right heart, and this is notably the case in asthma. While I do not agree with Kingscote,[11] that a dilated heart

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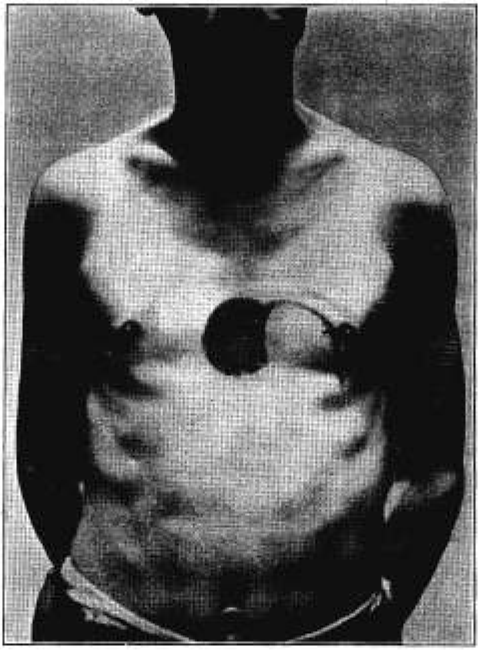
* Since writing the above I have directed attention to the "liver reflex" (Occidental Medical Times, September, 1903). This reflex is readily available for diagnostic purposes. It consists essentially of retraction of the lower liver border from a half-inch or more as determined by percussion, after irritation of the skin contiguous to the lower liver border. The liver reflex is pronounced in enlargement of the liver dependent on hyperæmia, and slight or absent, if due to connective-tissue hyperplasia.



The cardiosplanchnic phenomenon. The shaded area is the circumscribed patch of dulness elicited after vigorous compression of the abdomen ; the contiguous area is the superficial or absolute cardiac dulness.

is the invariable concomitant of asthma, yet I do contend that an enlargement of that viscus is operative in predisposing to a paroxysm and augmenting its severity. In a severe asthmatic attack which resisted the conventional remedies, a vacuum cup to the abdomen arrested the attack. In this instance, suggestion probably played no rôle, insomuch as the relief of the paroxysm coincided with the disappearance of substernal dulness.

It is unnecessary to adopt the theory of Kingscote that a dilated heart striking the vagi is responsible for nocturnal exacerbations of asthmatic paroxysms, for an overburdened right heart is a sufficient explanation. Indeed, the predominance of dyspnœic attacks at night in cardiorespiratory affections can be explained by the augmented blood supply to the right ventricle, the mere result of recumbency. In my opinion the upright posture instinctively assumed in orthopnœa is not only due to the fact that the extraordinary muscles of respiration may work to better advantage, but also for the additional reason that the blood from the right heart is enabled to gravitate to the splanchnic veins. In dyspnœa from any cause the implication of the heart in this symptom may be gauged by expressing blood from the right heart by means of the vacuum cup applied to the abdomen; if the dyspnœa is relieved we have reasonable assurance that it is caused by an overburdened heart. Many other instances could be cited to show the importance of this phenomenon in diagnosis, but the examples already mentioned will suffice. In treatment, the phenomenon suggests many possibilities in the direction of re-establishing the circulation and in relieving the heart when it is overtaxed. While the estimation of blood tension is a reliable gauge in estimating the value of any therapeutic method which has for its object cardiac stimulation, yet we cannot deny the fact that cardiac activity may be awakened without any corresponding increase in blood tension, just as we may awaken the respiratory centre by cutaneous stimulation without any necessary increase beyond the normal in the number and depth of the respirations.

My own observations show that the elicitation of the cardiosplanchnic phenomenon is unattended by any increase in the blood tension. Our only guide in estimating the amount of blood which is diverted to the right heart is the cardiosplanchnic phenomenon, not only the phenomenon *per se*, but the degree of its demonstration. The precordial dulness is, as has already been intimated, not so much dependent on the approximation of the heart to the chest wall, but rather to the amount of blood contained in the cardiac chambers. The following manœuvres in order of citation will express the largest amount of blood to the right heart: 1. Suspension by the feet, a method easy of execution in children. 2. Inversion of the patient. 3. Compression of the abdomen. 4. Recumbency. Inversion or suspension of the subject by the feet accentuates the dulness to the left of the lower sternal region and diminishes it over the latter area. In syncope it appears to me that the object achieved is not so much the determination of blood to the anæmic brain as it is to the determination of blood to the heart. To effect compression of the abdomen in acute conditions demanding cardiac stimulation, paroxysmal abdominal compression will suffice; in chronic conditions a firm cushion applied to the abdomen and secured by a rubber bandage or broad strap which permits of any degree of traction will prove serviceable. The objection to continuous abdominal compression is the respiratory embarrassment often experienced by the patient. An overtaxed right heart is present in so many cardiorespiratory conditions that it may be apposite to select croupous pneumonia as a paradigm. There are so many indications and contraindications cited by writers for venesection in this affection that it is really problematic whether bleeding is beneficial or harmful; at any rate, it is an empirical practice. It appears to me that in pneumonia our object should be to preserve the quantity of blood, for it is the chief stimulus for maintaining the cardiopulmonary circulation and furnishes the leukocytes, which do so much in conducing to a favorable issue. Instances do occur when bleeding is justifiable, and it would prove more effective if the patient were bled into his own vessels. The application of a vacuum cup to the abdomen meets the emergency and should be employed, if only as a tentative measure, should an overburdened heart with its consecutive phenomena warrant its employment. If this manœuvre is effective, it may be repeated any number of times, as it is a method harmless and painless if the exhaustion of the cup is not executed beyond a reasonable degree. It may be remarked in conclusion that alterations in blood tension do not synchronize with the intensity of the cardiosplanchnic phenomenon. This may be explained by the fact that the great amount of blood which is expressed into the right heart makes the latter unable for the time being to disburden itself of this large access of blood. The condition thus induced is somewhat similar to that when the breath is held, and Marey has shown, by tracings of the right ventricle when breathing is suspended, that its beats become slower and that it manifests an increasing difficulty in emptying itself, the amount of residual blood increasing with every beat.

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